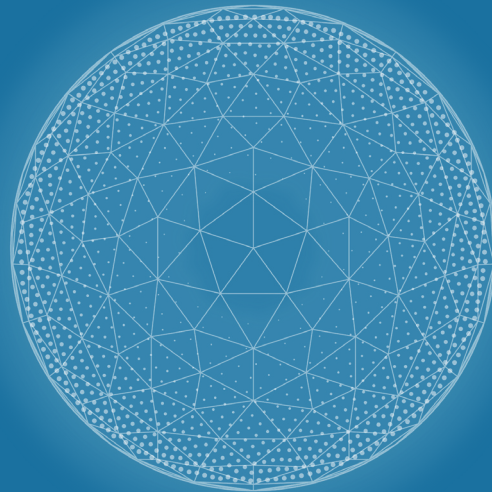


# DESIGNING THE FUTURE OF DIGITAL INFRASTRUCTURE FOR SMART CITIES and COMMUNITIES



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Digital transformation and infrastructure innovations are creating the potential for visionary players in the smart cities ecosystem to step into the critical role of “innovation orchestrator.” In this role they will be conductors of entire ecosystems, enabling innovative citizen and community experiences that are accompanied by a whole new realm of lucrative digital services.

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WHITE PAPER

# Transforming the Future of Smart Digital Infrastructure

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When it comes to preparing for the global information economy of the 21st century, most people assume that “the technologists are taking care of it.” They take it on faith that the best possible designs for the future of digital infrastructure and networking will emerge from large incumbent carriers and cable services providers.

But those are big, unfounded assumptions. In fact, most entrenched players are showing little appetite for radical departures from current practices. Yet current practice will not serve the needs of a genuinely connected world.

Orchestrating digital infrastructure innovations creates an opportunity for a new generation of communications investors and developers to create open ecosystems that will deliver innovative services to a much wider range of communities. Digital infrastructure developers like Ubiquity Management are driving new business models that facilitate changes in where and how digital infrastructure is developed.

Ubiquity invests, develops and manages critical communications infrastructure throughout the United States focusing on developing high-capacity fiber communications infrastructure in suburban markets. Ubiquity’s unique skills and experience accelerate development of digital infrastructure to underserved communities that want the same access and services as the largest urban centers provide, including:

- » Building one network to connect residents, businesses, wireless systems, data centers, and city services.
- » Replacing single use exclusive networks with open-access networks that foster more choices in services, providers, and cost.
- » Synchronizing a robust ecosystem of ISPs, wireless carriers, utilities and innovators to provide new community and commercial services.
- » Providing the up-front investment and taking on the technical and financial risks.
- » Adopting a long-term mindset that addresses future needs, but is also flexible enough to address changes in technology, regulations and demand.

Smart, connected Infrastructure-as-a-Service is enabling a new generation of sustainable communications solutions that foster economic growth and development. Ubiquity’s mission focuses on providing customer choice and spurring competition, both essential components of empowering communities for the future.

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People understand digital systems are interwoven into nearly every aspect of life and increasingly expect more from the technology they consume.

## **DIGITAL NATIVES ARE DRIVING THE FUTURE OF INFORMATION SERVICES**

In a mere two decades, the digital transformation of every aspect of human affairs has been profound enough to make silicon-based computation seem almost as important to our evolution as DNA itself. The undeniable and irreversible effects are visible everywhere: In our personal and immediate communications, our supply chains, the data revolution, the early beginnings of true AI. Thus it can be tempting to believe that the impact of high technology on society and business is over. In fact, it's only just begun.

We have entered an era where people, businesses and social organizations understand the profound impacts awareness, intelligence and collaboration bring. Today, billions of individuals across communities, organizations and businesses are interacting with billions and soon trillions of smart communicating devices, that are radically changing the way we learn, work and innovate.

The first wave of this transformation has also changed human psychology and behavior in ways that are equally noticeable, though sometimes harder to isolate. It has often been observed that the first cohort of “digital natives”— also known as the “mobile generation”— have attitudes toward learning and work, consumption and savings, and ownership and freedom that are noticeably different from the age groups that came before them. And while their differences may have been created by digital disruption, the members of this generation are now clearly influencing the ongoing transformation.

Perhaps the most salient point is that these attitudes are saturating our society at large. The standard demanded by one segment of consumers rapidly becomes the standard for everyone. The expectations of digital natives are quickly becoming the expectations of the generations who came before and come after them.

Today, people understand digital systems are interwoven into nearly every aspect of life and increasingly expect more from the technology they consume. To meet the demand for new digital experiences and deliver technology solutions that improve people's lives, we need to modernize the foundational elements of our digital infrastructure.

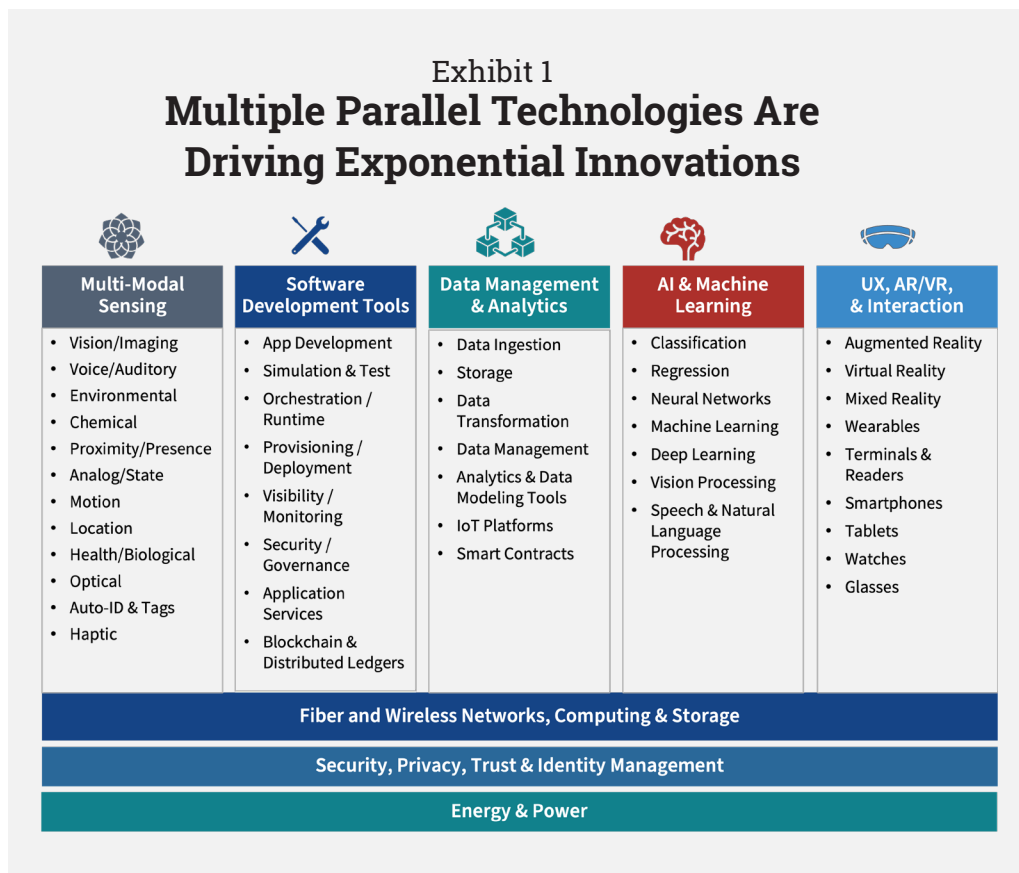
And yet architects, developers and investors struggle to build new innovations on top of legacy technologies that simply cannot support the required scale, performance and flexibility necessary for modern digital services. We need to think about networks in a completely new way, one that not only addresses performance and information services but also addresses identity, trust and equitable access in ways not currently addressed.

## CATALYTIC INNOVATIONS ARE ENABLING A NEW GENERATION OF NETWORK SERVICES

Today, multiple parallel technology developments are increasingly reinforcing and accelerating one another. Higher performance fiber optic-based and 5G networks are extending the reach of digital services. Cloud infrastructure resources are providing unprecedented computing scale. Machine learning and AI are bringing intelligence to diverse devices, and embedded systems and Internet of Things (IoT) technology are connecting and integrating a broad array of physical and digital applications.

**Broadband industry investment reached a twenty-year high in 2021, with investment reaching \$86 billion in the nation's infrastructure.**

*Source: US Telecom*



Each of these technologies is powerful on its own, but “catalytic” combinations of these capabilities are multiplying their impacts. Human-connected devices and machine-connected IoT devices enable exponentially more data. The cloud

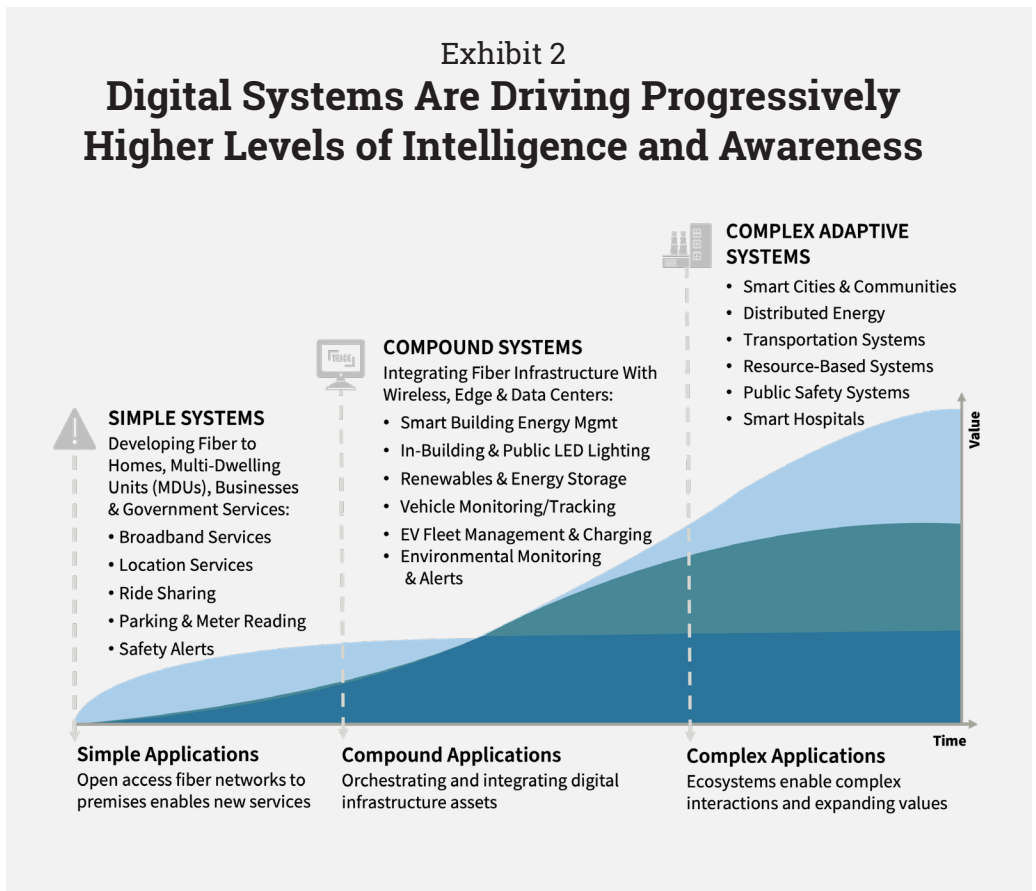


then enables us to capture, analyze and model many phenomena through its computational capacity. This in turn sets the stage for AI and machine learning tools to analyze and capture new insights.

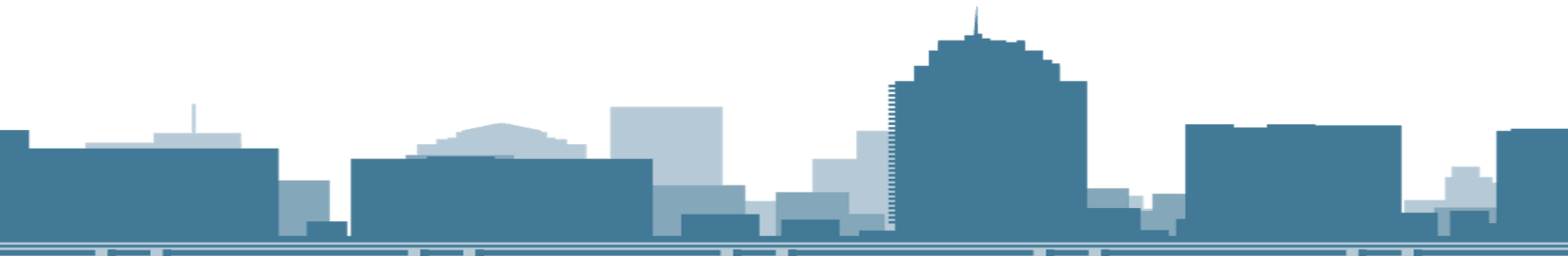
A new generation of higher performance fiber and 5G networks are driving a cycle of decentralization and distribution of digital resources. Powerful distributed technologies such as edge computing, IoT, blockchain and more are demonstrating the power of decentralized systems, relationships and interactions, and potentially setting the stage for a new era of large-scale collaboration and problem solving.

Collectively these innovations inform what we call “Smart Digital Infrastructure”—a new generation of networking, computing and data architecture that looks very different from classical computing and information systems and represents the emergence of complex adaptive and autonomous systems.

The Covid-19 crisis has tested the limits of our networks and communications infrastructure exposing many weaknesses and the critical need for a new generation of digital infrastructure.



For the last ten years or so, the evolution of digital systems has been largely comprised of moving data and workloads from physical hardware to virtual platforms. Developers have moved the data center to the cloud and businesses have transitioned from managing their own computing and network assets to “everything as a service.” We have transformed diverse processes from manual



human mediated workflows to automation supported by cloud services and mobile apps. Digital innovations have transformed the way we work with distributed, low-cost access to content and information services.

Enabling these digital innovations has forced developers to move compute, storage and networking resources from their traditionally centralized locations, such as data centers, to distributed and edge locations that are closer to where data is generated and consumed. This architectural shift is changing the economics of information systems reducing the costs and significantly increasing the flexibility of computing and networking resources which, in turn, is changing how businesses operate. This shift to distributed systems is enabling a much larger number of businesses across the economy to access powerful new tools such as AI and new personalized microservices.

We have entered an era where citizens, businesses and institutions are beginning to understand the immense impacts and benefits modern infrastructure can bring. Enabling physical infrastructure with digital technologies will extend its value into new realms including sustainability and social equity. Smart digital infrastructure has the potential to create significant new services for cities, communities and citizens.

## **THE BUILDING BLOCKS OF FUTURE INFRASTRUCTURE**

This paper is about an important new investment and development approach for digital infrastructure from people who are thinking about the scope and on the scale that next generation infrastructure deserves—Ubiquity Management.

Ubiquity invests in, develops and manages digital communications infrastructure. Ubiquity partners with ISPs, wireless carriers, utilities, and municipalities to deliver connectivity and sustainability solutions in underserved communities. Ubiquity's focuses on providing open access networks that spur competition and enable customer choice empowering cities, towns and communities for the future.

Before delving into the new thinking that makes all this possible, let's talk about why it's necessary at all. Aren't network systems progressing rapidly? Haven't new communication technologies like 5G revolutionized user experiences? And isn't the market for smart city systems scaling quite sufficiently?

Almost everyone will answer with a resounding "Yes!" But consider this analogy from Buckminster Fuller: Suppose you are traveling on an ocean liner that suddenly begins to sink. If you rip the lid off the grand piano in the ballroom, throw it overboard, and jump on it, the floating piano lid may well save your life. But if, under normal circumstances, you set about to design the best possible life preserver, are you going to come up with the lid of a grand piano?

**Ubiquity  
Management  
is a new breed  
of investor  
and developer  
of digital  
infrastructure  
providing  
open access  
networks that  
enable customer  
choice and spur  
competition.**

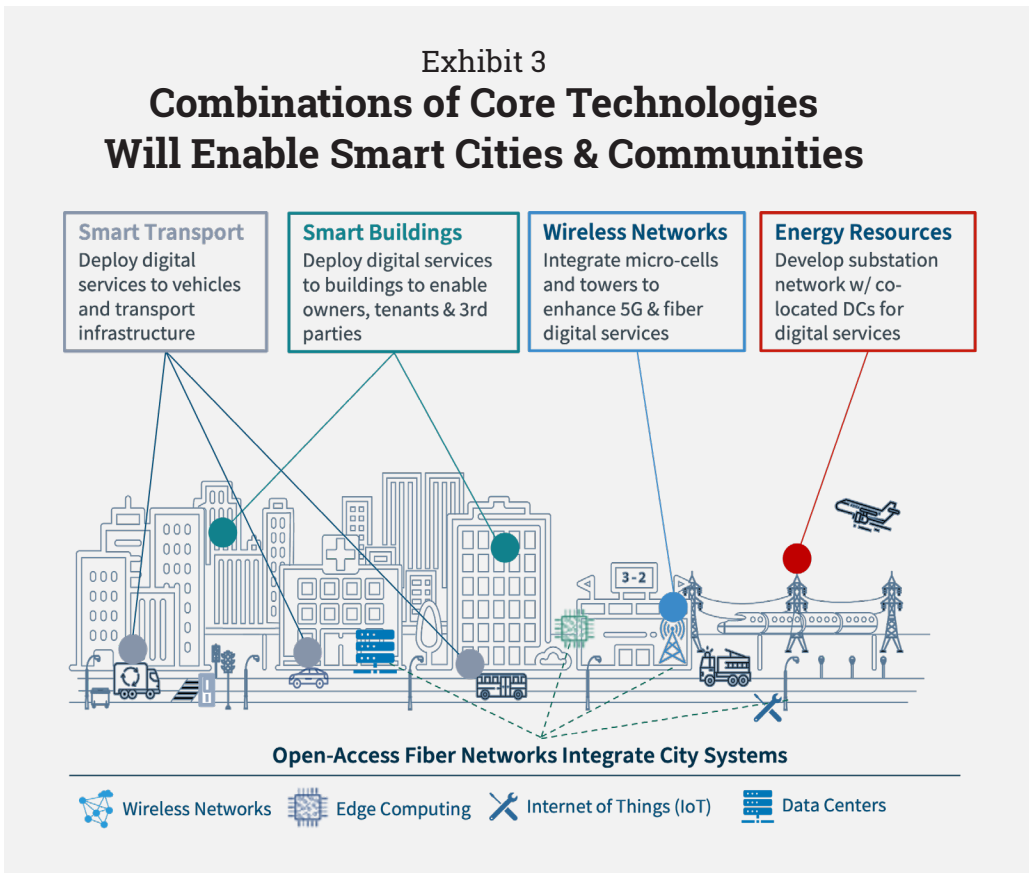


The evolution of smart digital infrastructure for cities and communities is like that piano lid. In a period of great change and tumult, it worked—in the sense that it kept us afloat. But that does not make it the best possible design, or qualify it to be something that we should plan to live with forever.

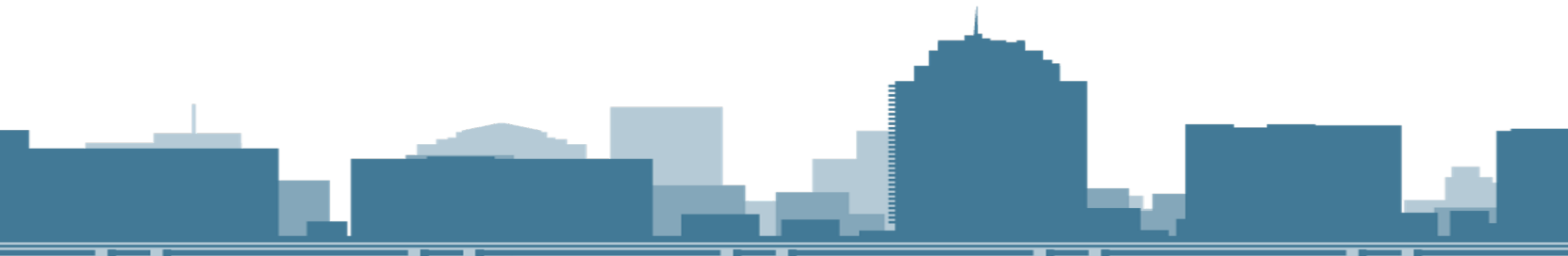
The Covid-19 crisis, as much as any single trend, has tested the limits of our networks and communications infrastructure, exposing many weaknesses. Video streaming services, on-line games and endless Zoom meetings have all been competing for more and more bandwidth. This pressure on bandwidth has led to an outsized interest in 5G technology. So much so that 5G has become the savior technology in everyone’s mind.

A 10 percentage point increase in broadband penetration can lead to a 1.2% jump in real per capita GDP growth in developed economies.

Source: World Bank



The technology will certainly improve. 5G is still in its infancy and will take several different forms dependent upon the different spectrums that wireless service providers such as T-Mobile, AT&T and Verizon have access to. But 5G will not solve all problems for all users. Without higher performance, more resilient network connections to most if not all cell sites and towers, 5G will remain somewhat limited its performance and services.





The shift to truly intelligent distributed systems requires a new generation of architectural capabilities that are designed and built from the ground up. Networking, computing, data management, applications and identity have all, for the most part, evolved in relatively autonomous development paths. This will need to change.

As the number and diversity of stakeholders expands (users, architects, developers, supporters, etc.), and the volume and nature of their interactions grows, the discrete technologies that comprise digital infrastructure will need to become more and more tightly coupled. Each core technology must be viewed in close proximity to all of the other core technologies and, by necessity, need to be mutually supportive without inhibiting the other core technologies.

Ubiquity sees the continuously evolving relationship between these core technologies as fertile ground for innovation. They need to be interwoven and mutually supportive to leverage their combined potential. As is often the case with rapidly iterating technologies, all of this adds up to the need for a new architecture for distributed systems that is a profoundly different architecture than what's in common use today.

Ubiquity understands the need for open-access fiber optic networks that are designed to accommodate current and future network usage and enable robust ecosystems of broadband service providers, mobile carriers, government agencies, utilities and other value added participants.

## WHAT'S REQUIRED TO ENABLE SMART CITY DIGITAL SERVICES?

Cities, companies, researchers, and thought leaders are now zealously predicting powerful smart city applications and use cases, starting with smarter grids and buildings and progressing to autonomous vehicles and smarter transportation systems. However, these visions demand higher bandwidth networking technologies that are much more agile and precise than anything we've seen before.

Consider "multi-modal" sensing, which combines multiple types of sensors and data feeds that can be fused in real time. A simple application example could be the combination of video and auditory sensing for safety and security in a smart city setting where, if a gun shot is "heard" it can be quickly integrated with video and imaging feeds to spot where this occurred. Just like driverless vehicles where systems need to prevent pedestrians from being hit by cars or trucks, very low latency real-time networking can immediately notify public safety agencies about an incident while prioritizing multiple parallel data streams.

**Ubiquity's goal is to build once and provide capacity for 20-30 years of connectivity needs, supporting an unlimited number of tenants across wireless, ISPs, municipal networks and more.**

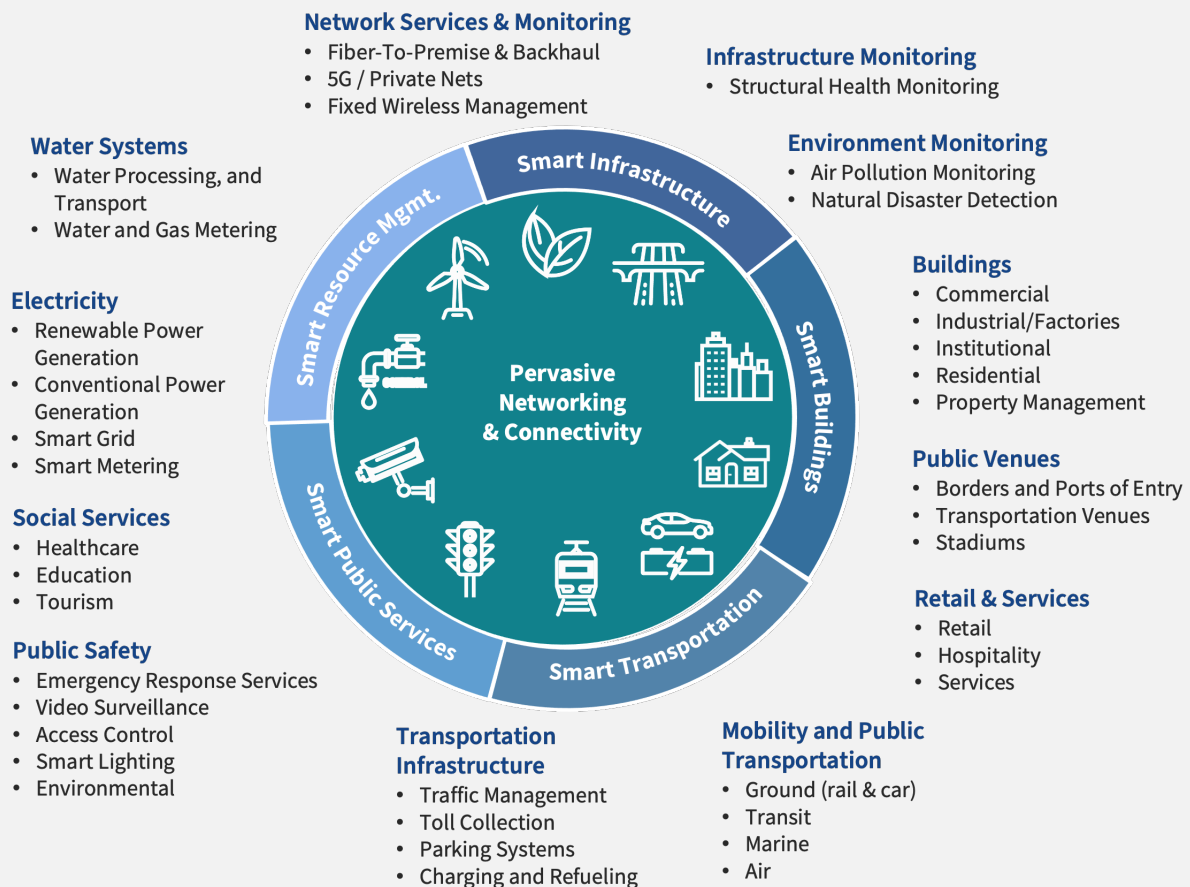


In the age of smart distributed systems, simply bolting together diverse edge devices ranging from sensors to micro data centers and integrating them onto 5G networks and then providing data intensive services doesn't add up to a coherent architecture. Integrating a diverse hodge podge of technologies will not render a seamless user experience or enable the MetaVerse environment we are anxiously awaiting.

The underlying technologies that are enabling more complex adaptive systems are all in some way trying to break from today's computing and networking paradigms. To reach this goal, a new view of architecture is required in order to overcome today's performance limitations. What are the major obstacles that need to be overcome?

### Exhibit 4

## Diverse Applications and Use Cases Require Higher Performance Networking Resources



- » First, we need to better orchestrate network resources to enable robust broadband services that inform diverse applications and use cases. Without virtually every cell site and tower having a fiber optic connection on a highly resilient network, 5G will remain somewhat limited. Right now, there just isn't enough fiber in the ground.
- » Second, we need to distribute and embed networking and compute resources into the physical structures and systems that surround us in our everyday lives. Today's discussions of data centers seem to focus almost exclusively on hyperscaling cloud resources when what we really need to do is utilize new design innovations to liberate computing that has been trapped in massive data centers and distribute these resources to the edge where they will be needed.
- » Third, we need better ways to manage data interactions and eliminate data boundaries - getting the application data close to its point of use while managing changes in the data quickly and consistently to enable fast, reliable and trusted application experiences - connecting users with the right code and the right data at the right time requires intelligent orchestration of application traffic and workloads across dynamic and distributed users and applications.

Next generation networks for smart cities and communities will need to be higher performance, real-time, open access networks.

## UBIQUITY'S VALUE PROPOSITION

The COVID-19 pandemic has altered the landscape of our cities in a very short time period. Cities like Austin, Charlotte, Portland and Denver, are booming as people who are seeking more affordable living space are relocating from from large urban centers like New York and San Francisco to more affordable, less dense cities that still offer culture and diversity of a larger global hub, but at a smaller scale.

Even before the pandemic, these cities have been growing by as much as 15-30% because of their lower cost of living, lower cost of doing business, lighter tax burden, higher rate of job growth and more affordable housing. Digital infrastructure and services are increasingly seen as a key driver of the attractiveness and competitiveness of cities and communities. Ubiquity is strategically focusing on these underserved markets where its unique skills, investment capabilities and experience will accelerate development of new digital infrastructure.

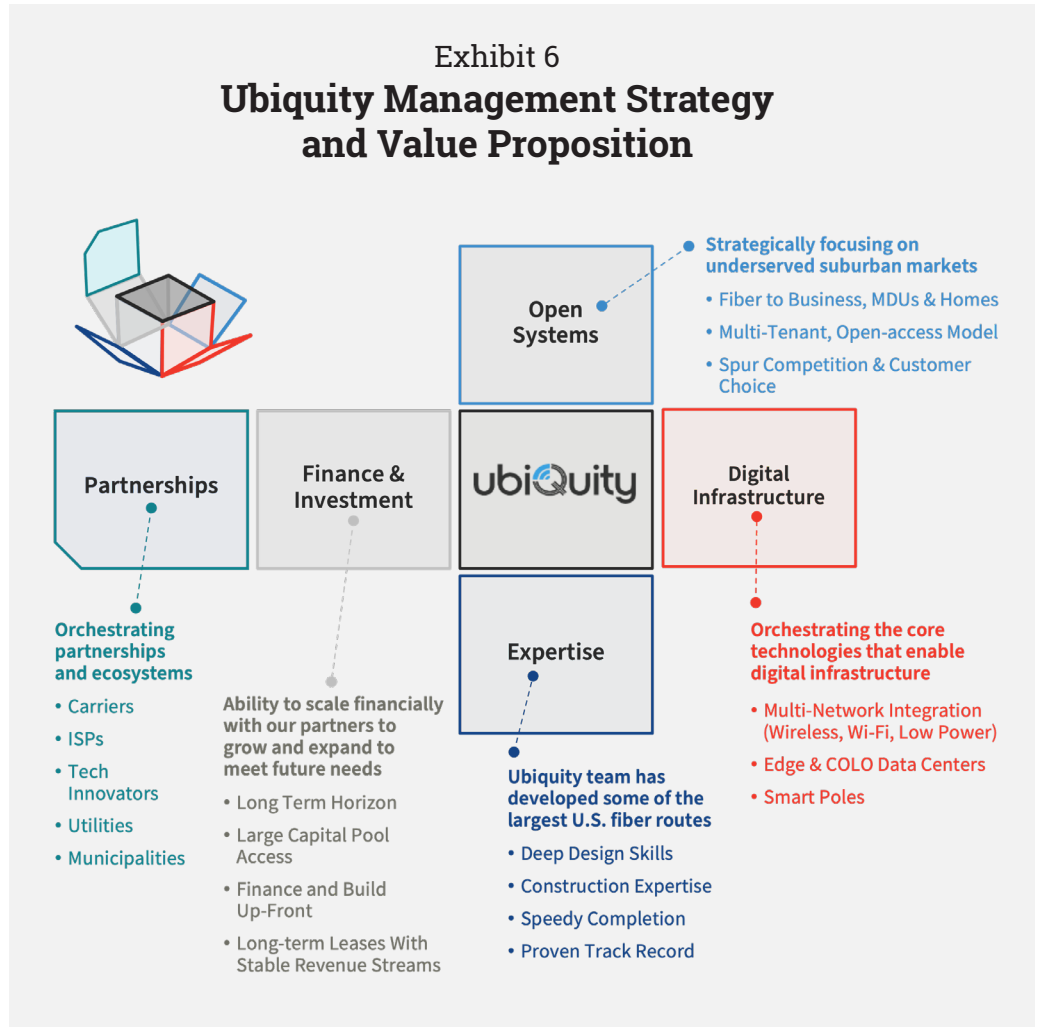
Ubiquity's strategy is intended to accelerate the deployment of high-capacity fiber infrastructure to the rapidly expanding underserved cities where there is a distinct need to provide communities the same access to multiple providers of telecommunications services as the largest urban centers.

The underlying technologies that are enabling complex adaptive systems are all trying to break away from today's networking and computing paradigms.

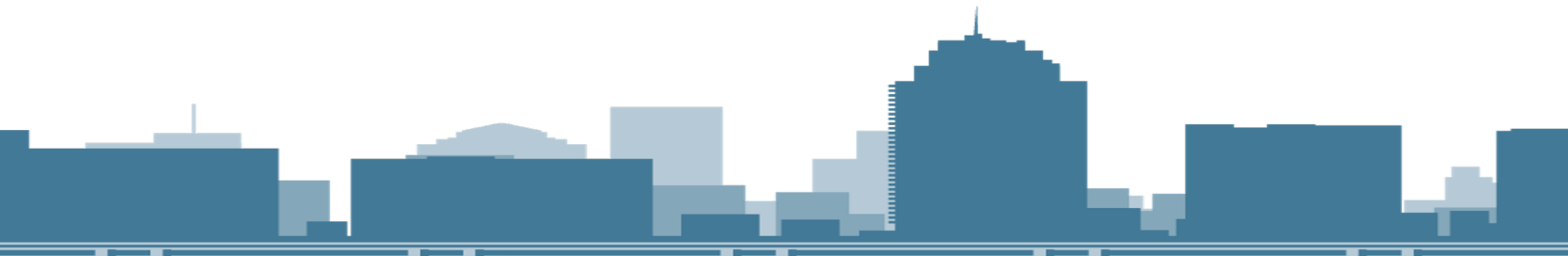


Ubiquity’s multi-tenant, open-access model addresses current and future needs. This approach differs from current fiber build models that favor a single carrier that offers service to a specific type of end user such as cell tower companies. Instead of multiple companies deploying capital to build single-use networks, Ubiquity’s model invites tenants to connect to customers investment free providing long-term access contracts. This approach not only provides choice of service to residents and businesses but offers nearly limitless capacity for future expansion and new smart city use cases.

Smart digital infrastructure innovations are creating an opportunity for a new generation of investors and developers to create collaborative ecosystems.



Investing in infrastructure, including more environmentally friendly energy and resource systems, can boost job creation, economic growth and quality of life. Many economists see infrastructure spending as having a significant multiplier effect. The economic gains that come from \$1 of infrastructure investment contribute as much as \$3 to gross domestic product (GDP) growth.



Ubiquity is driving a new business model that facilitates changes in where and how digital infrastructure is developed based on the following principles:

- » **Dig Once, Connect Everything for Decades** -- building one pipe to connect residents, businesses, cell sites, data centers and city services.
- » **Extend Core Digital Infrastructure and Services** -- providing the same scale and scope of core digital infrastructure systems in the largest urban centers to the rapidly expanding suburban arena.
- » **Freedom of Choice** – reducing single use exclusive network services and give everyone more choices in broadband services, providers and cost.
- » **Upgrade Antiquated Networks** -- offering the fastest speeds and providing multiple connection options.
- » **Speed of Deployment** -- providing cities and communities with sophisticated investment, network development, construction and management capabilities from a team that has built some of the largest fiber routes in the US.
- » **Investment In the Future** -- organizing development with a 20+ year time horizon to accommodate both current and future connectivity needs. .

Ubiquity understands that the era of monolithic command-and-control network services is coming to an end. The new reality is open access, multi-purpose network services where carriers, ISPs, cable providers and technology developers work collaboratively to better understand the user's needs and desired experience. As this shift occurs, we will begin to see many new innovations and services grow from smarter digital infrastructure.

## THE SPECIAL ROLE OF INNOVATION ORCHESTRATOR

Mastering digital transformation involves a subtle dance of timing and delivery. Technology innovation always moves faster than the development and marketing of actual products and services. Part of the ecosystem story is the ability to see where, and how fast, capabilities are going and thus provide services to users and customers before the next technological wave makes them obsolete.

Consider that during the long life span of city assets like buildings, transportation systems and similar, ten or more cycles of new innovations will occur in various sub-systems and components. Take a building for example. During the decades-long

Digital infrastructure is a key driver of the attractiveness, competitiveness and sustainability of cities and communities.

Recent study found fiber broadband investment increases rental and property values in multi-dwelling units (MDUs) by 8 percent and) 2.8 percent respectively.

*Source: Fiber Broadband Association*



lifespan of a commercial building, several cycles of major innovation will occur in various embedded devices and equipment. Physical infrastructure systems such as power distribution might remain more or less constant, but many other sub-systems—such as LED lighting—are now designed in a modular way and can be swapped out when they become superseded.

Though no one can predict precisely when new innovations mature, the process by which they will be delivered is becoming clear. Transforming infrastructure with new digital tools is creating the potential for visionary players to step into the important role of “digital infrastructure orchestrator”—that is, to become the enablers of new digital innovations and the facilitators of new alliances and relationships based upon information-sharing and co-creation of new solutions.

**Multi-year investment Westfield MA has realized over \$88 million annually in job-related benefits from the installation of fiber optic broadband.**

*Source: Fiber Broadband Association*

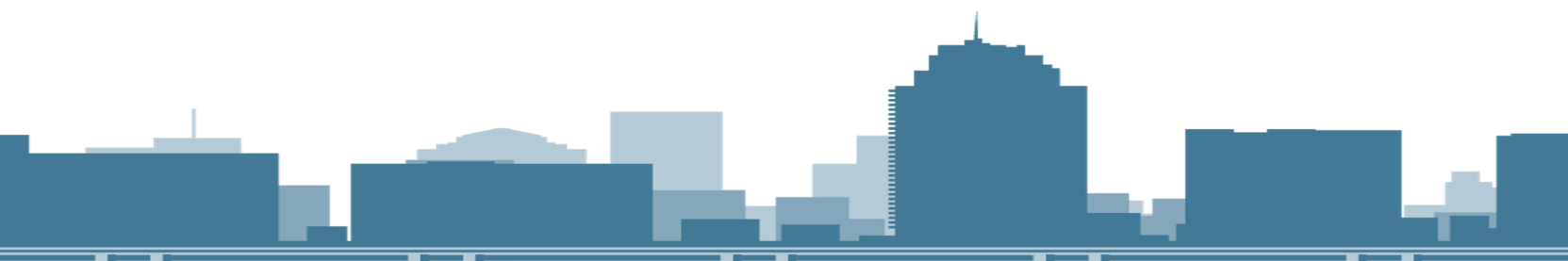
Architecture-driven orchestrators will need to stand in their prospective partners’ shoes and work through the logic of how these collaborative systems get designed, procured and deployed. It won’t be a classic linear product development cycle. Old-fashioned customization gives way to configurable tools and systems, while the technology itself makes everything more programmable.

Orchestrating infrastructure innovations creates an opportunity for a new generation of investors and players to reach out to ecosystem participants and build empathy with potential partners and innovators. Digital infrastructure orchestrators and investors like Ubiquity will have the potential to help facilitate changes in how infrastructure and equipment systems are specified and developed, helping to synchronize diverse players and innovations.

The role of orchestrator will require unique knowledge of diverse technologies and a deep understanding of how networks, data and analytics will enable a new generation of smart city and infrastructure applications. Investors and developers are ideally positioned to help cities and communities as well as technology development organizations to solve tangible challenges, accelerate new digital capabilities and enable smart city applications.

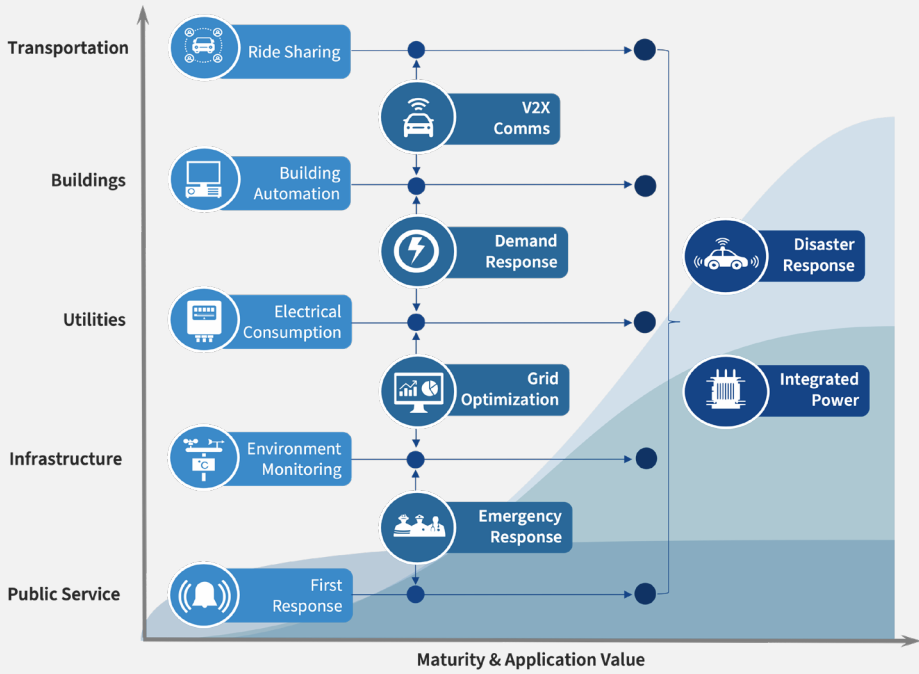
## **FUTURE PERFECT INFRASTRUCTURE - SMART and SUSTAINABLE**

Generate Capital and Ubiquity’s partnership to build high-quality fiber-to-the-premises networks and complementary sustainable digital infrastructure is a disruptive force in the smart city sector. Combining Generate’s infrastructure-as-a-service model and the Ubiquity team’s expertise in fiber and broadband offers municipalities and communities comprehensive access to digital and energy transition infrastructure solutions.



This new breed of partnership expands Generate’s energy transition and sustainability-focused platform into smart cities and digital infrastructure. It accelerates Ubiquity’s existing fiber broadband operations, and provides customers with a complete set of digital and sustainable energy solutions and a growing community of value-adding partners that expand the value of these investments.

**Exhibit 5**  
**Smart Digital Infrastructure & New Services**  
**Ecosystems Will Drive New Values and Capabilities**



Generate Capital and Ubiquity Management’s partnership to build high-quality fiber-to-the-premises networks and complementary sustainable digital infrastructure is a disruptive force in the smart city sector.

- |   |  |  |
|---|--|--|
| <p><b>Simple Applications:</b></p> <ul style="list-style-type: none"> <li>• Siloed, Single Function Applications</li> <li>• Minimal Ecosystem Collaboration Required</li> <li>• Relatively Low Value</li> </ul> | <p><b>Compound Applications:</b></p> <ul style="list-style-type: none"> <li>• Applications That Integrate Multiple City Functions</li> <li>• Partnerships &amp; Data Sharing Required</li> <li>• Moderate Value</li> </ul> | <p><b>Complex Applications:</b></p> <ul style="list-style-type: none"> <li>• Applications Considering All Relevant City Data</li> <li>• Open Ecosystem Collaboration Required</li> <li>• High Value</li> </ul> |
|---|--|--|

Collaborative communities both inform and express the value of a new digital infrastructure strategy. Built to pursue multiple aims simultaneously, a dynamic network of connected products, services, developers, users and stakeholders will drive new information services which, in turn, create new influences in the



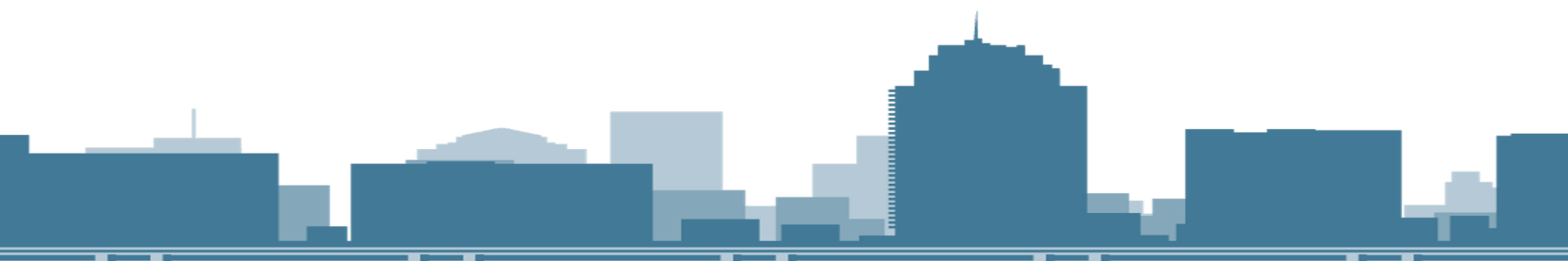
marketplace. Leverage and impact in collaboration structures fall to those who best understand how to use this information and influence to get and keep key positions.

Forging collaborative innovation communities means managing uncertainty and developing for the long term. Investors and developers like Generate and Ubiquity know that to achieve success they need to recognize the new opportunities driven by collaborative innovation - from customers, partners and internal teams. This will require new thinking, including:

**Forging collaborative innovation communities - with customers, innovators and services partners - means managing for the long term.**

- » **Act Early:** Assembling an ecosystems of collaborators calls for a balance of timing and carefully selected participants. Most community opportunities will quickly evolve and re-form as learning grows.
- » **Build Open Network Collaboration:** Collaborative communities and coalitions need to be comprised of self-motivated market participants that pursue a common goal, not mere subcontractors tied to a command and control scheme.
- » **Focus on Long Term Sustainability:** Collaborative ecosystems and communities create value and strengthen market leadership by focusing on long-term sustainable market leadership.
- » **Understand Customer Experience By Having Customers Participate:** Customer behavior is complex; multiple complimentary designers and developers carefully observing customer experience can enable a much richer and deeper appreciation of new smart city services offerings.
- » **Target the Highest Value Growth Opportunities:** Ecosystem participants often get distracted by the sheer size of a particular market segment or because of the their familiarity with it. In the process, they often miss the segments where collaborative communities could deliver the most value.

Radical new thinking about sustainable, intelligent city infrastructure and applications must begin at the most basic levels. The Generate and Ubiquity teams are creating a culture of continuous open innovation. Their combined understanding of sustainability and digital systems makes them the ideal partner and platform for communities and players looking to evolve and future proof their solutions. Ultimately, this ecosystem approach to development will radically alter how new digital designs and applications are realized, catapulting a new era of innovation.





# Harbor Research

Harbor Research has over thirty years of experience working with clients on growth strategy and new business creation. At the core of Harbor's approach is a deep understanding of the core technologies, markets and business characteristics as well as the management and organizational challenges companies face adopting and developing digital and smart systems technologies. We strive to generate deep insight into how emergent technologies drive value creation and competitive advantage in our clients' businesses and the economy as a whole.

For more information visit [www.harborresearch.com](http://www.harborresearch.com)